

REMARKS ON THE SYSTEM OF SMOKE-CONDUCTION AND VENTILATION ADOPTED AT OSMASTON MANOR.*

Four centuries have hardly elapsed since our forefathers found it necessary, for their personal comfort, to construct fire-places and flues in the walls of their houses, for the consumption of fuel and the removal of smoke; and it is well known how the skill of their architects converted the chimney stack and its terminations into picturesque, and even highly ornamental, features. It most also be acknowledged, that little progress, if any, has been made by their descendants, in improving upon the models thus bequeathed to them. In modern times, however, the superiority of workmanship exemplified in closely-fitting doors and windows, has rendered it highly requisite that greater attention should be given to the construction of chimney openings and fire-grates. Volumes of scientific research, and records of the application of true principles, have been published, and very great improvements have been made in the form of the chimney-back and the open grate; but the separate flue, with its consequent termination, has continued to retain its ordinary form, and, though the stack and the shaft have been varied to suit the architectural character of the building, the attempted cure of smoky chimneys has been confined to the mouth of the flue, or to innumerable contrivances at the top of the stack.

The system of smoke-conduction and ventilation now proposed for consideration has no claim to novelty, except in one particular, as partial combinations of smoke and ventilation flues have been adopted for several years in places where peculiarity of situation, or other circumstances, rendered the application necessary. Indeed, the germ of the principle of descending and ascending flues is observable in the well-known ventilation of mines, in which the air, sucked downwards through the short leg of the downcast shaft, traverses immense galleries, carrying with it smoke and foul air, and is ultimately discharged at the top of the upcast shaft; the greater altitude of the latter, combined with the application of strong heat at some part of its length, causing and increasing the draught.

The particular points of difference which the present example presents, in comparison with others of a like kind, consist in the application of the principle to a residence on a large scale, having open fire-places, and in the traction of all the smoke and foul air generated in the house, offices, stables, conservatories, and green-houses, into one large detached vertical shaft.

Mr. Francis Wright, with whom I had the pleasure of co-operating in the erection of his house, and to whose energy and fixedness of purpose the successful result in this instance is mainly attributable, intended at first to erect a house with high pitched roofs, gables, and chimneys; but the situation being high, it was considered that the irregular points of such a building would hardly form a satisfactory skyline, and it was therefore abandoned for a design, marked by horizontality of general form, in the style of James I. It was moreover thought desirable that the roofs should serve as terraces or platforms, at different levels, from which the beautiful scenery of the adjacent country might be enjoyed, without inconvenience from smoke. As the use of ordinary chimney flues and stacks would have been incompatible with this condition, recourse was had to Mr. Sylvester's suggestion for the removal of the smoke, by the means which would also prevent its return into the rooms, and allow such a combination of the ventilating arrangements, as would render the action of the whole efficacious and regular. At this stage of the proceedings, Mr. Sylvester was called in, and this portion of the work, with other economical arrangements, has been carried on, more or less, under his direction.

From observation and experience it appears, that the principle now under consideration can only be successfully carried out where the following conditions are fulfilled:—

1. The addition of a system of artificial ventilation, whereby the quantity of air necessary for combustion is supplied in a pure state, which, in its progress to the chimney, changes the air of the apartment.

2. The perfect insulation of the flue, so as to be free, if possible, from the influence of atmospheric changes, and the temperature of the external air.

3. The securing, as nearly as possible, an equable temperature throughout the whole length of shaft.

4. The application of heat at the base of the vertical shaft, sufficient to force the current upwards, at the point where the horizontal flue is connected with the chimney stack.

5. The absence of all right angles in the connection of the collateral flues with the main ducts, on the principle which would be most efficacious in promoting the rapid and unchecked flow of water in pipes or drains.

6. Such a height of shaft as shall always be considerably above the highest fire-place in the building, increasing in an accelerating ratio with the heights of the fire-places above the level of the horizontal duct. The upper part of the chimney stack should be entirely clear of all surrounding trees or buildings, otherwise a turn-cap may be necessary to prevent downward currents in storms or windy weather.

In the case of a large house, with its numerous apartments enveloped by a medium ever in motion, and with its internal atmosphere more or less sympathetic with the currents of the outer air, a variety of novel circumstances are called into operation, which complicate the action of the simple principle, and increase the difficulty of its application. The general system observed in the plan of Osmaston Manor, is the combination of the portion used as a dwelling, with its domestic offices, stables, conservatories, and gardens, in one connected arrangement, by which the distance of the kitchen gardens and hot-houses is also reduced to the least space, compatible with a due regard to appearance and shelter. The general cold-air shaft forms a tower at one angle of the kitchen, and it is connected with the heating apparatus by means of the underground shaft, shown on the basement plan. The upper part of the shaft is provided with a turn-cap, moved by a spindle and vane, which insures the regular supply of air downwards, by keeping the open side of the cap always turned towards the wind. There is also a central tower in the house, rising to the height of 30 feet; and a clock-tower at the angle of the conservatories forms the centre of the stable court.

The smoke-shaft is placed in the centre of the kitchen garden at a level 20 feet higher than the ground floor of the house, and a rise of several feet is thus obtained throughout the underground main flue, from the retaining wall to the base of the shaft, which is in itself favourable, as it increases the velocity of the current.

As to the manner in which the fire-grates in the rooms are set, the formation of the back, and its connection with the flue,—the back hearth is a grating, under which there is a shuttle, which, being opened, allows the ashes to fall into the smoke flue, into which all accumulated dust and light ashes are removed immediately by the strength of the current, without the slightest inconvenience in the apartment. The front hearth and grating are cast in one piece, and the former is generally covered with Staffordshire tiles, through which a considerable amount of heat is transmitted from the radiation of the iron. The back of the grate is formed with louvres, through which the smoke passes into the flue, the size of the opening being regulated by a rod connected with the front of the fire-place.

The ordinary smoke flues are formed of elliptical Staffordshire tiles, which, being glazed inside, do not allow any considerable accumulation of soot, and descend as nearly vertical as possible to the underground brick flue. These horizontal or secondary tunnels are built of brick or stone, perfectly air-tight, and they turn invariably a very acute angle at their connection with the main tunnel, so as to offer the least obstruction to the forward cur-

rent. In the construction of the main underground tunnel between the building and the smoke shaft in the kitchen garden, the sides, bottom, and arched top are formed of nine-inch brick-work, between which and the earth the outer space is filled up with solid concrete, care being taken to preserve good drainage from the same underneath the inverted arch of the tunnel. The whole of the outer surface of the upper vault was covered with tar, burnt into the joints of the brick-work, over which a coating of gas tar and gravel, 3 inches thick, was spread, to receive the concrete. By the use of stone springers, the inner arched flue was constructed of half brick (the arch being turned in short lengths), and it is thus surrounded by an air-tight vacuum, which serves as a non-conductor of atmospheric influence, while the other means adopted are effectual in rendering the whole water-tight. The horizontal tunnel has a double connection with the great shaft; and the boilers used for heating the hot-houses and garden walls, being fixed immediately under this part, effectually accelerate the draught in the curved junction between the horizontal tunnel and the vertical shaft. It is proposed to fix a small gasometer in this part, from which the gas will be conveyed in pipes throughout the smoke tunnels.

In assigning to the main descending and ascending shafts their relative position upon the plan, we were governed by local circumstances, and considerations of obvious convenience in the arrangement. As the architect is generally trammelled by such considerations, it will not be of any practical utility to give rules for the relative position of the shafts, further than that, where possible, it is better to place the air-shaft towards the direction of the prevailing wind, which in this country blows most frequently from the west.

The shaft is 150 feet high from the ground, which is at this point 32 feet above the cellar floor level: there is, therefore, a total altitude of 182 feet for the ascent of the smoke to the ultimate discharge. This shaft, with the whole of the external face of the walls of the house and offices, is built of dark gray limestone obtained in the neighbourhood. It is 21 feet square at the base, and 17 feet square at the top, under the corbelled cornice. It stands exactly in the centre of the middle garden wall: on each side, ranges of hot-houses are in course of erection. The smoke shaft is circular, 8 feet in diameter internally, and stands for its entire height from the ground line in the garden, quite free for the outer casing: the space between the shaft and the outer wall of the tower is occupied by cast iron winding steps, with landings at every eighth step: they are laid into the outer, but do not touch the inner wall. Very easy access is thus given to the gallery at the top, which commands fine views of the property, and the surrounding country. This mode of construction is applicable to large chimneys of every description. The instability of many large shafts is owing to the disturbing effects of the expansion of the brickwork near the heated smoke current, which has sometimes a temperature of 200° to 300° above that of the external air, and the consequent expansion varies from 1 to 2 inches.

The cold-air shaft is 8 feet square internally, 12 feet square externally, and 63 feet high from the ground line in the kitchen court: it is provided with a turncap and vane, to render the action constant and unvarying, and is connected with an underground flue, of the same dimensions, running parallel with the horizontal smoke tunnel, and supplying the heating apparatus with pure fresh air, whence it is transmitted to the apartments in a very agreeable condition. A constant circulation is maintained from the apparatus, in winter and summer, throughout the apartments, to the several chimneys or other ventilating apertures, until it ultimately finds its way to the top of the large shaft. Hot water apparatus, upon Mr. Sylvester's principle, is fixed in certain portions of the distant flues, so as to render the action as regular as possible throughout the whole of the apartments. Connections are also formed by flues in the wall with all the baths, water-closets, or other places where

* From a paper read at the ordinary meeting of the Royal Institute of British Architects, by Mr. E. F. Stevens, on Monday, April 24th.